CLAIMS

What is claimed is:

1. A process for producing liquid hydrocarbons from synthesis gas comprising:

contacting a gas stream comprising hydrogen and carbon monoxide in a multiphase reactor comprising a reaction vessel having an internal diameter (Dr) of greater than or equal to 0.6 m and a plurality of internal structures arranged within said reaction vessel under operating conditions effective to convert at least a portion of the gas streams to liquid hydrocarbon synthesis products, wherein the internal structures are arranged such that they create a plurality of reaction zones within the reaction vessel, wherein each reaction zone is in fluid communication with at least one adjacent reaction zone, and wherein the plurality of internal structures is configured such that each of the reaction zones has a characteristic size Ds that is less than the reaction vessel internal diameter Dr.

2. The process according to claim 1 wherein Dr is in the range of about 0.6 m to about 10 m.

3. The process according to claim 1 wherein Dr is equal to or greater than 10 m.

4. The process according to claim 1 wherein the plurality of reaction zones is created by patterned arrangements of the internal structures.

5. The process according to claim 4 wherein the patterned arrangements comprise create a cross-sectional shape of the reaction zones selected from the group consisting of circular, rectangular, diamond, concentric circular, and any combination thereof.

6. The process according to claim 1 wherein the structures are arranged in various patterns to create repeating reaction zones.

7. The process according to claim 1 wherein Ds is between about 0.15 meter and about 0.6 meter.

8. The process according to claim 1 wherein each of the plurality of internal structures has a characteristic size d, and wherein d is smaller than Ds.

9. The process according to claim 1 wherein each of the plurality of internal structures has a characteristic size d, and the spacing Di between centers of adjacent internal structures is between about 1.1d and about 4d.

10. The process according to claim 9 wherein d is from about 2.5 cm to about 13 cm (about 1-5 inches).

11. The process according to claim 1 wherein the reaction vessel has a height to diameter ratio between about 0.5 and about 20.

12. The process according to claim 1 wherein each of the reaction zones has a height to diameter ratio between about 7 and about 180.

13. The process according to claim 1 wherein the internal structures include heating or cooling tubes.

14. The process according to claim 1 wherein the internal structures are parallel so as to create parallel reaction zones.

15. The process according to claim 1 wherein the synthesis products comprise C_{5+} hydrocarbons.

16. The process according to claim 1 wherein the internal structures comprise an area of about 10% to about 25% of the cross-sectional area of the reaction vessel.

17. The process according to claim 1 wherein the internal structures comprise a non-uniform configuration.

18. The process according to claim 17 wherein the internal structures comprise a completely non-uniform configuration at 5% to 20% of the total area of the reaction vessel.

19. A gas-agitated multiphase reactor with a low degree of backmixing suitable for hydrocarbon synthesis, comprising:

a reaction vessel characterized by an internal diameter Dr of greater than or equal to 0.6 m;

a liquid disposed inside the reaction vessel;

a gas distributor disposed near the bottom of the reaction vessel, said gas distributor being suitable for dispersing a gas phase through the liquid and creating a gas flow and a fluid flow; and

a plurality of internal structures disposed within said reaction vessel,

wherein the plurality of internal structures is arranged so as to create a plurality of reaction zones within the reaction vessel,

wherein each reaction zone is in fluid communication with at least one adjacent reaction zone, and

wherein the plurality of internal structures is configured such that each of said reaction zones has a characteristic size Ds that is less than the reaction vessel internal diameter Dr.

20. The reactor according to claim 19 wherein the plurality of reaction zones is created by patterned arrangements of internal structures.

21. The reactor according to claim 20 wherein the patterned arrangements comprise create a cross-sectional shape of the reaction zones selected from the group consisting of circular, rectangular, diamond, concentric circular, and any combination thereof.

22. The reactor according to claim 20 wherein the structures are arranged in various patterns to create repeating zones.

23. The reactor according to claim 19 wherein Dr is in the range of 0.6 m to 10 m.

24. The reactor according to claim 23 wherein Dr is greater than or equal to about 1.2 meters.

25. The reactor according to claim 24 wherein Dr is greater than or equal to about 1.8 meters.

26. The reactor according to claim 19 wherein Dr is greater than or equal to 10 m.

27. The reactor according to claim 19 wherein Ds is between about 0.15 meter and about 0.6 meter.

28. The reactor according to claim 19 wherein Ds is between about 0.15 meter and about 0.5 meter.

29. The reactor according to claim 19 wherein the reaction vessel has a height to diameter ratio between about 0.5 and about 20.

30. The reactor according to claim 19 wherein each of the reaction zones has a height to diameter ratio between about 7 and about 180.

31. The reactor according to claim 19 wherein each of the plurality of internal structures has a characteristic size d, and wherein d is smaller than Ds.

32. The reactor according to claim 19 wherein each of the plurality of internal structures has a characteristic size d, and the spacing Di between centers of adjacent internal structures is between about 1.1d and about 4d.

33. The reactor according to claim 19 wherein Di is between about 1.2d and about 3d.

34. The reactor according to claim 19 wherein Di is between about 1.2d and about 3d.

35. The reactor according to claim 19 wherein d is from about 2.5 cm to about 13 cm (about 1-5 inches).

36. The reactor according to claim 19 wherein d is from about 4 cm to about 10 cm (about 1.6-4 inches).

37. The reactor according to claim 19 wherein the plurality of internal structures comprises components having walls that are permeable to gas or liquid.

38. The reactor according to claim 19 wherein the reaction vessel further includes a solid phase and said solid phase is retained outside said walls during operation.

39. The reactor according to claim 19 wherein the reaction vessel further includes a solid phase and said solid phase is retained inside said walls during operation.

40. The reactor according to claim 19 wherein the internal structures are parallel so as to create repeating parallel reaction zones.

41. The reactor according to claim 19 wherein the internal structures includes tubes or rods.

42. The reactor according to claim 19 wherein the internal structures comprise components having cross-sectional shapes selected from the group consisting of circular, trilobe, oval, rectangular, square, and irregular shapes.

43. The reactor according to claim 19 wherein the internal structures include heating or cooling tubes.

44. The reactor according to claim 19 wherein the multiphase reactor further comprises one or more tubular structures wherein the tubular structures are permeable to gas and liquid.

45. The reactor according to 19 wherein the gas-agitated multiphase reactor is a hydrocarbon synthesis reactor.

46. The reactor according to 19 wherein the gas-agitated multiphase reactor is a slurry bubble column.

47. A method for reducing backmixing in a large scale gas-agitated multiphase reactor comprising:

providing a reactor vessel having a bottom and a plurality of internal structures arranged within said reaction vessel and an internal diameter Dr greater than or equal to about 0.6m, wherein said reaction vessel contains a liquid, wherein the internal structures are arranged so as to create a plurality of reaction zones within the reaction vessel, and wherein each of said reaction zones has a

characteristic size Ds that is less than the reaction vessel internal diameter Dr; and passing a gas phase from the bottom of the reactor vessel through said liquid into the plurality of reaction zones so as to create a liquid flow in each of the reaction flow zones; wherein the liquid flow in each of the reaction flow zones has a liquid axial dispersion coefficient lower than that of a liquid flow in the reaction vessel without internal structures.

48. A reactor comprising:

a large diameter reaction vessel capable of having liquid contained therein;

a means for introducing gas into the reaction vessel; and

a means for reducing the liquid axial dispersion coefficient and backmixing within the reaction vessel.

49. The reactor of claim 48 wherein the means for reducing comprises a non-uniform distribution of internal structures.

50. The reactor of claim 48 wherein the reaction vessel has a diameter of greater than or equal to 0.6m.